CLAIMS

That which is claimed is:

1. A loop reactor apparatus comprising:

a plurality of major segments;

a plurality of minor segments;

wherein each of the major segments is connected at a first end to one of the minor segments, and is connected at a second end to another of the minor segments, such that the major and minor segments form a continuous flow path adapted to convey a fluid slurry;

at least two pumps for imparting motive force to the fluid slurry within the reactor, each pump operably connected to an impeller disposed in the continuous flow path;

wherein two of the impellers face each other and rotate in opposite directions and the two impellers are spaced sufficiently close so that one of the impellers benefits from the rotational energy of the other of the impellers;

means for introducing an olefin monomer into the continuous flow path;

means for introducing a diluent into the continuous flow path;

means for introducing a polymerization catalyst into the continuous flow path; and

means for removing a portion of a fluid slurry from the continuous flow path.

2. A loop reactor apparatus according to claim 1 wherein the two impellers are disposed in the same segment.

3. A loop reactor apparatus according to claim 1 wherein a portion of the continuous flow path upstream of at least one of the impellers houses at least one guide vane arranged to impart rotational motion in a direction opposite to the rotational motion of the impeller.

4. A loop reactor apparatus according to claim 1 wherein at least one impeller is situated in an enlarged section of one of the segments, and the enlarged

section and the at least one impeller have diameters greater than a diameter of the segments.

5. A loop reactor apparatus according to claim 1 wherein at least one impeller and the segment which houses the impeller define a clearance, and the clearance is 1/16 inch or less.

6. A loop reactor apparatus according to claim 5 wherein the clearance is 1/64 inch or less.

7. A loop reactor apparatus according to claim 1 wherein each impeller has a diameter greater than the average diameter of the segments.

8. A loop reactor apparatus according to claim 1 wherein each impeller consists of a material selected from the group consisting of titanium, aluminum and steel.

9. A loop reactor apparatus according to claim 1 wherein each impeller is a solid mass of metal having no substantial voids.

10. A loop reactor apparatus according to claim 1 wherein the loop reactor apparatus defines a reactor volume, and the reactor volume is 30,000 gallons or more.

11. A loop reactor apparatus according to claim 1 wherein the loop reactor apparatus defines a reactor volume, and the reactor volume is 33,000 gallons or more.

12. A loop reactor apparatus according to claim 1 wherein the loop reactor apparatus defines a reactor volume, and the reactor volume is 35,000 gallons or more.

13. A loop reactor apparatus according to claim 1 wherein the major segments are vertical.

14. A loop reactor apparatus according to claim 1 wherein the major segments are horizontal.

15. A loop reactor apparatus comprising:

a plurality of major segments;

a plurality of minor segments, each minor segment connecting two of the major segments to each other, whereby the major and minor segments form a continuous flow path;

a monomer feed attached to one of the segments;

a catalyst feed attached to one of the segments;

a product take-off attached to one of the segments;

an upstream pump and a downstream pump, wherein the pumps each are attached to an impeller disposed in the interior of the continuous flow path, and the pumps are arranged so that the impellers rotate in opposite directions and are sufficiently close so that the rotational energy imparted by the upstream pump is at least partially recovered by the downstream pump;

wherein the impellers are situated in at least one enlarged section of one of the segments, the enlarged section and the impellers having diameters greater than diameter of the segments.

16. A loop reactor apparatus according to claim 15 wherein the two impellers are disposed in the same segment.

17. A loop reactor apparatus according to claim 15 wherein a portion of the continuous flow path upstream of at least one of the impellers houses at least one guide vane arranged to impart rotational motion in a direction opposite to the rotational motion of the impeller.

18. A loop reactor apparatus according to claim 15 wherein at least one impeller is situated in an enlarged section of one of the segments, and the enlarged section and the at least one impeller have diameters greater than a diameter of the segments.

19. A loop reactor apparatus according to claim 15 wherein at least one impeller and the segment which houses the impeller define a clearance, and the clearance is 1/16 inch or less.

20. A loop reactor apparatus according to claim 19 wherein the clearance is 1/64 inch or less.

21. A loop reactor apparatus according to claim 15 wherein each impeller has a diameter greater than the average diameter of the segments.

22. A loop reactor apparatus according to claim 15 wherein each impeller consists of a material selected from the group consisting of titanium, aluminum and steel.

23. A loop reactor apparatus according to claim 15 wherein each impeller is a solid mass of metal having no substantial voids.

24. A loop reactor apparatus according to claim 15 wherein the loop reactor apparatus defines a reactor volume, and the reactor volume is 30,000 gallons or more.

25. A loop reactor apparatus according to claim 15 wherein the loop reactor apparatus defines a reactor volume, and the reactor volume is 33,000 gallons or more.

26. A loop reactor apparatus according to claim 15 wherein the loop reactor apparatus defines a reactor volume, and the reactor volume is 35,000 gallons or more.

27. A loop reactor apparatus comprising:

a plurality of major segments;

a plurality of minor segments, each minor segment connecting two of the major segments to each other, whereby the major and minor segments form a continuous flow path;

a monomer feed attached to one of the segments;

a catalyst feed attached to one of the segments;

a product take-off attached to one of the segments;

at least one guide vane disposed within the continuous flow path; and

a pump, wherein the pump is attached to an impeller disposed in the interior of the flow path downstream of the guide vane, wherein the guide vane and the impeller impart rotational motion on the flow path in opposite directions and are sufficiently close so that the slurry is engaged in rotational motion upon engaging the downstream pump.

28. A loop reactor apparatus according to claim 27 wherein at least one impeller is situated in an enlarged section of one of the segments, and the enlarged section and the at least one impeller having diameters greater than a diameter of the segments.

29. A loop reactor apparatus according to claim 27 wherein at least one impeller and the segment which houses the impeller define a clearance, and the clearance is 1/16 inch or less.

30. A loop reactor apparatus according to claim 7 wherein the clearance is 1/64 inch or less.

31. A loop reactor apparatus according to claim 27 wherein each impeller has a diameter greater than the average diameter of the segments.

32. A loop reactor apparatus according to claim 27 wherein each impeller consists of a material selected from the group consisting of titanium, aluminum and steel.

33. A loop reactor apparatus according to claim 27 wherein each impeller is a solid mass of metal having no substantial voids.

34. A loop reactor apparatus according to claim 27 wherein the loop reactor apparatus defines a reactor volume, and the reactor volume is 30,000 gallons or more.

35. A loop reactor apparatus according to claim 27 wherein the loop reactor apparatus defines a reactor volume, and the reactor volume is 33,000 gallons or more.

36. A loop reactor apparatus according to claim 27 wherein the loop reactor apparatus defines a reactor volume, and the reactor volume is 35,000 gallons or more.

37. A loop reactor apparatus according to claim 27 wherein the major segments are vertical.

38. A loop reactor apparatus according to claim 27 wherein the major segments are horizontal.

39. A loop slurry polymerization process comprising:

introducing monomer, and catalyst to a loop reactor;

polymerizing the monomer to form a slurry comprising solid polyolefin particles in a liquid medium;

circulating the slurry using two impellers;

imparting a first rotational motion to the slurry with a first of the impellers;

imparting a second rotational motion to the slurry with a second of the impellers, wherein the second rotational motion is opposite to the first rotational motion.

40. The loop slurry polymerization process of claim 39 further comprising pre-swirling the slurry upstream of the first impeller, in a direction opposite to the first rotational motion of the impeller of the first impeller.

41. The loop slurry polymerization process of claim 39 further comprising post-swirling the slurry downstream of the second pump, in the same direction as the second rotational motion of the impeller of the second pump.

42. A loop slurry polymerization process according to claim 39, further comprising minimizing a clearance between at least one impeller and a portion of the loop reactor housing the impeller.

43. A loop slurry polymerization process according to claim 39, wherein the slurry has a concentration of the solid polyolefin particles of at least about 45 weight percent and at most about 75 weight percent.

44. A loop slurry polymerization process according to claim 39, wherein the slurry is circulated at a flow of from about 20,000 gallons/minute to about 50,000 gallons per minute.

45. A loop slurry polymerization process according to claim 39, wherein the impeller achieves a head of from about 120 feet to about 240 feet.

46. A loop slurry polymerization process comprising:

introducing monomer, diluent, and catalyst to a loop reactor;

polymerizing the monomer to form a slurry comprising the diluent and solid polyolefin particles;

circulating the slurry using at least one impeller;

imparting a first rotational motion to the slurry prior to the slurry reaching the at least one impeller;

imparting a second rotational motion to the slurry with the at least one impeller, wherein the second rotational motion is in a direction opposite to the first rotational motion.

47. A loop slurry polymerization process according to claim 46 wherein the first rotational motion is imparted by pre-swirl vanes.

48. A loop slurry polymerization process according to claim 46, further comprising minimizing a clearance between at least one impeller and a portion of the loop reactor housing the impeller.

49. A loop slurry polymerization process according to claim 48, wherein the clearance is 1/64 inch or less.

50. A loop slurry polymerization process according to claim 46, wherein the slurry has a concentration of the solid polyolefin particles of at least about 45 weight percent and at most about 75 weight percent.

51. A loop slurry polymerization process according to claim 46, wherein the slurry is circulated at a flow of from about 20,000 gallons/minute to about 50,000 gallons per minute.

52. A loop slurry polymerization process according to claim 46, wherein the impeller achieves a head of from about 120 feet to about 240 feet.

53. A loop reactor apparatus comprising:

a plurality of major segments;

a plurality of minor segments, each minor segment connecting two of the major segments to each other, whereby the major and minor segments form a continuous flow path for carrying slurry;

a monomer feed attached to one of the segments;

a catalyst feed attached to one of the segments;

a product take-off attached to one of the segments;

a pump within an arced pump case, the pump case being positioned in one of the segments, the pump having at least one impeller mounted on a shaft, the impeller having blades that are oriented at an angle between 0 to 90 degrees to the

shaft, the pump having a bulge positioned along the shaft proximate the at least one impeller, such that a curved flow path is defined between the bulge and the pump case, the flow path being disposed such that the slurry flows by the blades and is redirected out of the pump case by the flow path.

54. A loop reactor apparatus according to claim 53, further including guide vanes situated along the flow path to redirect the rotational flow of the slurry upon discharge from the impeller.

55. A loop reactor apparatus according to claim 53, further including a second pump having an impeller opposite the pump, wherein the impellers of the pumps face each other and rotate in opposite directions and the impellers are spaced sufficiently close so that one of the impellers benefits from the rotational energy of the other of the impellers.

56. A loop reactor apparatus according to claim 55, wherein at least one of the impellers is situated in at least one enlarged section of one of the segments, and the enlarged section and the impeller situated therein have diameters greater than the diameter of the segments.

57. A loop reactor apparatus according to claim 53, wherein the pump is a mixed pump having at least two impellers.

58. A loop reactor apparatus according to claim 53, wherein a portion of the continuous flow path upstream of the impeller houses at least one guide vane arranged to impart rotational motion in a direction opposite to the rotational motion of the impeller.

59. A loop reactor apparatus according to claim 53, wherein the impeller and the segment which houses the impeller define a clearance, and the clearance is 1/16 inch or less.

60. A loop reactor apparatus according to claim 53, wherein the impeller has a diameter greater than the average diameter of the segments.

61. A loop reactor apparatus according to claim 53, wherein the impeller consists of a material selected from the group consisting of titanium, aluminum and steel.

62. A loop reactor apparatus according to claim 53, wherein the impeller is a solid mass of metal having no substantial voids.

63. A loop reactor apparatus according to claim 53, wherein the loop reactor apparatus defines a reactor volume, and the reactor volume is 50,000 gallons or more.

64. A loop reactor apparatus according to claim 53, wherein the major segments are vertical.

65. A loop reactor apparatus according to claim 53, wherein the major segments are horizontal.

66. A loop reactor apparatus comprising:

a pipe loop reactor adapted for conducting an olefin polymerization process comprising polymerizing at least one olefin monomer to produce a fluid slurry comprising solid olefin polymer particles in a liquid medium;

a monomer feed attached to the pipe loop reactor;

a catalyst feed attached to the pipe loop reactor;

a product take-off attached to the pipe loop reactor; and

at least one mixed flow pump disposed within the pipe loop reactor.